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Stock assessment of pomfrets off west coast of India

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ABSTRACT

Pomfrets contribute 36 501 tonnes to the annual marine fish landings in India. *Pampus argenteus* and *Formio niger* are the prime species forming 65.0% and 34.0% respectively of the pomfret catch. Gujarat and Maharashtra share 42.6% and 35.9% of *P. argenteus* and 33.3% and 22.8% of *F. niger* exploited, respectively.

The growth parameters for *P. argenteus* off Maharashtra and Karnataka and MSY off Maharashtra (9 551 tonnes) and Karnataka (374 tonnes) were estimated. The results indicated high fishing pressure to the extent of 40% off Karnataka. Large-scale destruction of young ones by dol nets at Bessein (Maharashtra) resulted in recruitment overfishing as the catches came down to 565 tonnes (1991) from 5 612 tonnes (1984).

The growth parameters for *F. niger* for Kerala and Karnataka were estimated. MSY estimates were 1 055 tonnes off Kerala and 1856 tonnes off Karnataka. The effort needs to be reduced by 60% off Karnataka.

Pomfrets support a lucrative and commercially important fishery both along the east and the west coasts of India. They are represented by three species viz., the silver pomfret *Pampus argenteus* (Euphrasen), the black pomfret *Formio niger* (Bloch) and chinese pomfret *Pampus chinensis* (Euphrasen). They contributed on an average 36 501 tonnes annually to the all-India marine fish landings during 1984–88, forming 1.7 to 3.5%.

Along the Indian coast, the pomfrets are exploited by a variety of gears such as drift nets, dol nets, purse seines and trawls. Earlier studies relating to the fishery and biology of silver pomfret are those of Kuthalingam (1963), Sivaprakasam (1963), Sulochanan and Rao (1964) Gopalan (1967), Pati (1980 and 1982), and Zafar Khan (1982).

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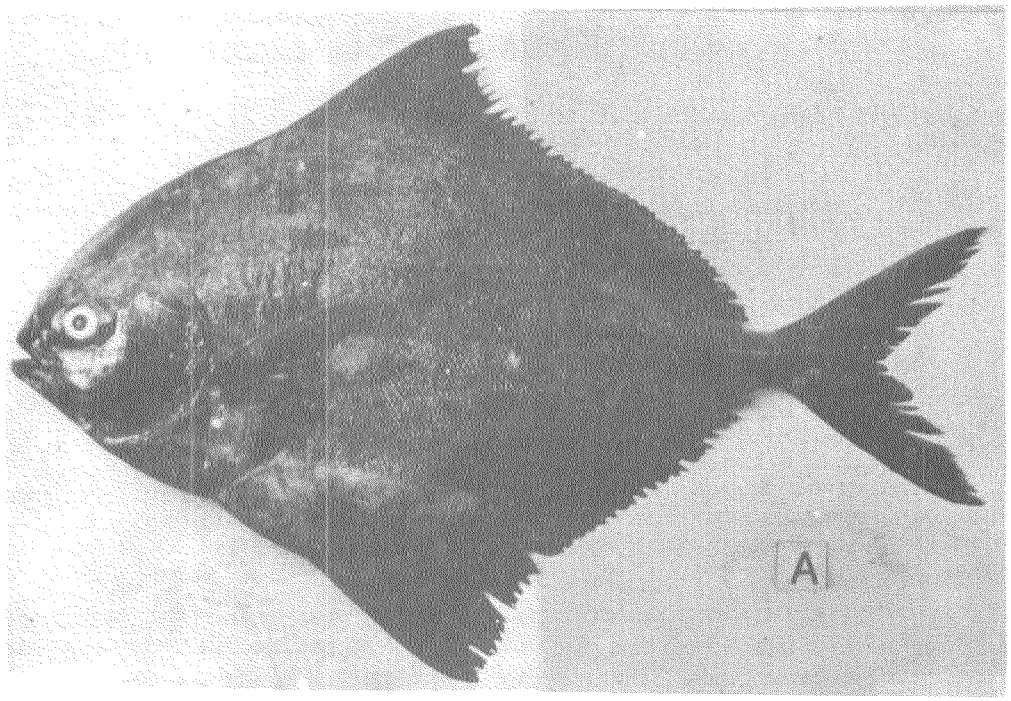
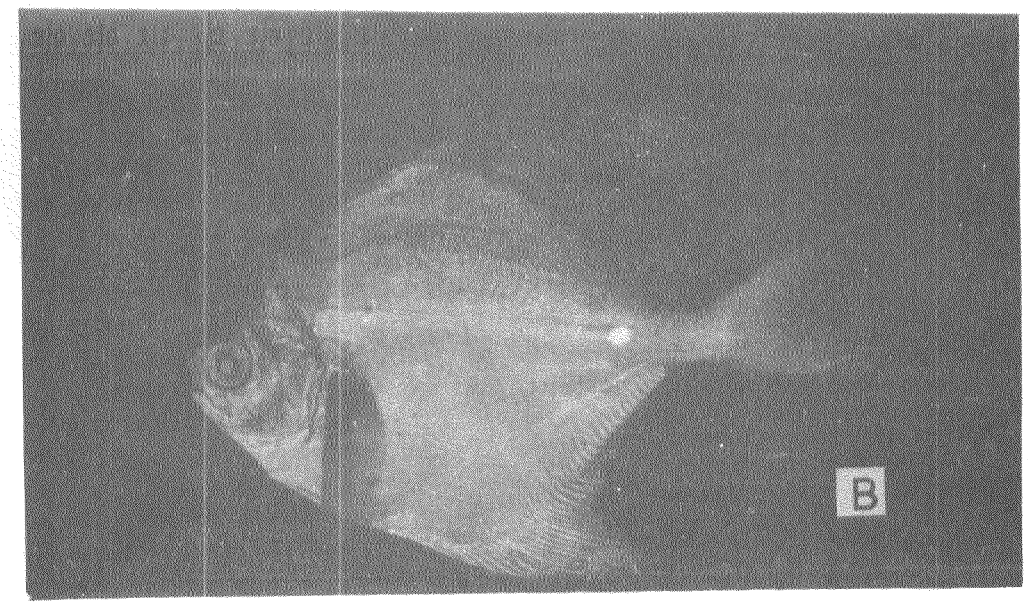
MATERIALS AND METHODS

The basic data on effort and catch were collected from different centres as per Sekharan (1965) together with length measurement and sample weight. The data were based on the catches of mainly drift net except in Karnataka where data were collected from trawlers. Furcal length for *P. argenteus*, and total length for *F. niger* was taken. The length measurements were grouped in 10 mm interval and the number of fish in each size group was estimated. The data were processed as per the methods of Zafar Khan (1989).

Growth parameters L_∞ and K were estimated using ELEFAN I programme (Gayanilo *et al.* 1988). The estimates of stock size and fishing mortalities were obtained by cohort analysis (Jones 1984). Yield (catch in weight) and stock biomass were predicted for various level of fishing effort using the length converted Thompson and Bell analysis (Sparre



A. Black pomfret



B. Silver pomfret

1985). The outputs of Jones' length cohort analysis, namely the recruitment and fishing mortalities formed the inputs for length converted Thompson and Bell analysis. The programme packages of LFSA and Statographics were used in the analysis of data.

RESULTS

Fishery

The all-India average annual landing of *P. argenteus* during the five year 1984–88 was 23 967 tonnes (Fig. 1). Maharashtra and Gujarat contributed 42.6% and 35.6% respectively. On the east coast, Andhra Pradesh and West Bengal and Orissa contributed about 8.5% and 9.5% respectively. The landings in Karnataka, Kerala and Tamil Nadu were comparatively low.

The annual average catch of *F. niger* was 12 534 tonnes during the period. The statewise catch is given in Fig.2. Maharashtra (33.3%) Gujarat (22.8%), Karnataka (11.4%) and Andhra Pradesh (14.6%) together accounted for the bulk of the landings. The landings in Tamil Nadu and West Bengal and Orissa were generally poor.

Seasonal variations: Pomfrets are available round the year and the landings in Maharashtra increase from Ist to IVth quarter. Though the catches are high in IV quarter, CPUE is more during IIIrd quarter (monsoon months) in both Maharashtra and Gujarat.

Species contribution: P. argenteus contributed 65% while *F. niger* 34% of the pomfret fishery. *P. chinensis* was not taken into consideration during this study. However, it formed about 1% of the pomfret landings in India.

Biology

F.niger is a carnivore, feeding on large zooplanktonic organisms like crustaceans, polychaetes and cuttle fish. The salpa, *Tasis zonaria* may be considered as an indicator of the abundance of this species (Sivaprakasam 1963). Copepods formed the major diet of *P.argenteus* in the Bay of Bengal

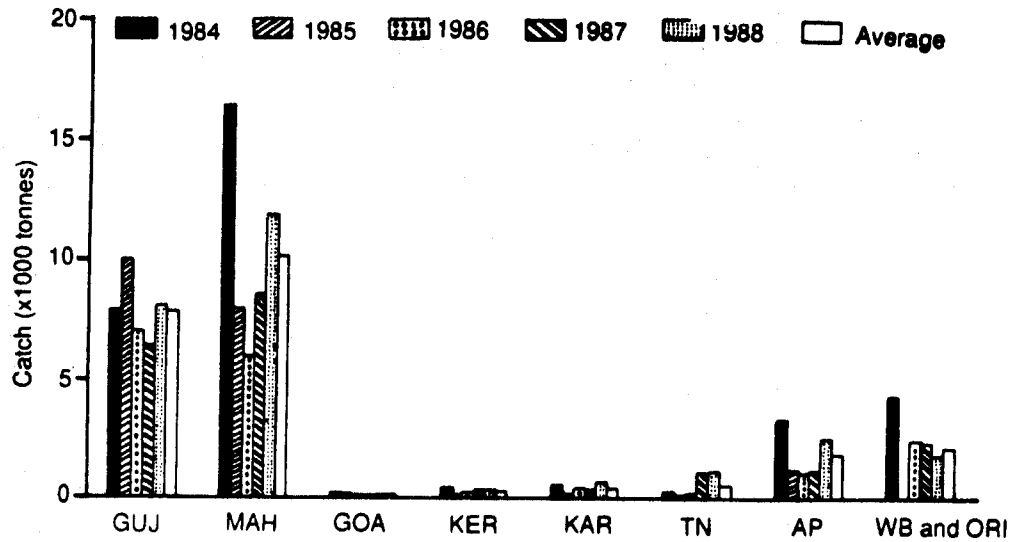


Fig. 1. Statewise catch of *Pampus argenteus* during 1984–88.

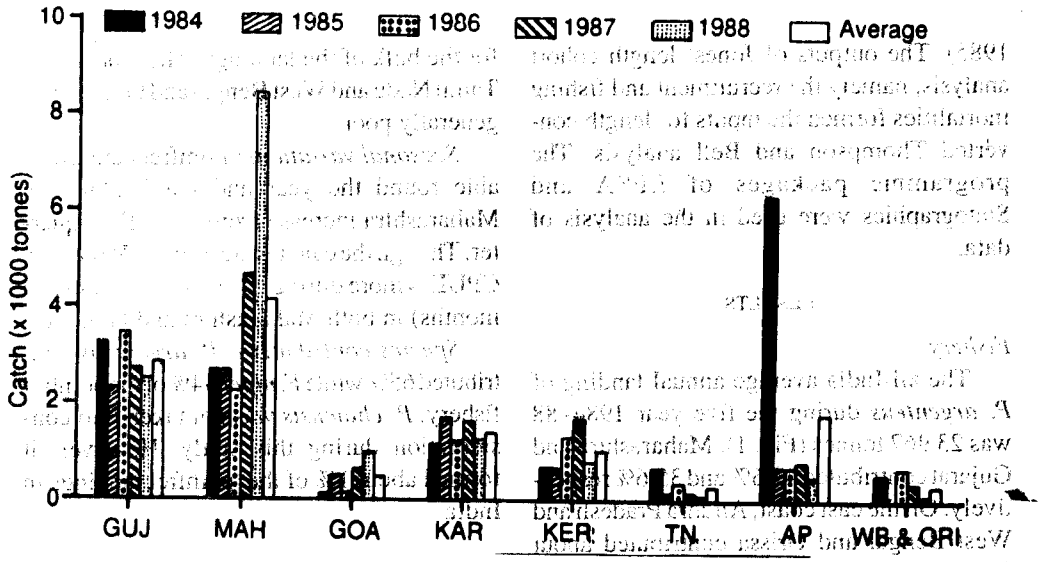


Fig. 2. Statewise estimated catch of *Formio niger* during 1984–88.

(Kuthalingam 1963, Pati 1980). Gopalan (1967) observed the size at first maturity for *P.argenteus* male as 22 cm and for female 26 cm (total length). Pati (1982) recorded size at first maturity as 14 cm for males and 17 cm for females (standard length). There are two spawning periods for *P. argenteus* with peak in April and August on the east coast of India. Gopalan (1967) observed a prolonged spawning season off Gujarat extending from February to August with peak during April–June. On the northwest coast also two spawning periods, February and August, were observed (Bapat *et al.* 1982). The area between 19°4' – 20°2' N and 70°2' – 71°2' E in the depth range of 55–90 m appeared to be the breeding ground of the species. *F. niger* also has prolonged spawning season extending from November to March (Bapat *et al.* 1982). Observations off Cochin indicated that *F. niger* spawns in almost all the months with peak during June–September. The size at first maturity for females has been estimated at 275 mm (total length) during this study. Sex-ratio was 1:1.

Stock assessment of silver pomfret Pampus argenteus

Maharashtra: Stock assessment studies made for Maharashtra are given below:

LENGTH-WEIGHT RELATIONSHIP: Length and weight data of 450 fish ranging from 140 and 322 mm (furcal length) gave relationship as

$$\log W = -4.49568 + 3.005864 \log L.$$

AGE AND GROWTH: It was assumed that growth of *P. argenteus* follows von Bertalanffy growth pattern (VBGF),

$$Lt = L_\infty (1 - e^{-K(t-t_0)})$$

The L_∞ and K were estimated by ELEFAN I for Maharashtra. The parameters are L_∞, 390 mm; and K, 0.7 (annual).

The growth curve identified by the ELEFAN is presented in Fig. 3. The method does not produce any estimate of t_0.

There was no earlier growth estimation available for *P. argenteus* except that by Morgan (1985) from Kuwaiti waters. L_∞ and

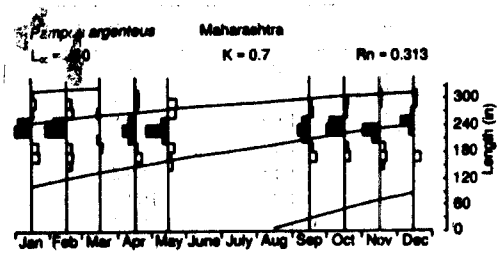


Fig. 3. The growth curve of *Pampus argenteus* identified by ELEFAN (Maharashtra).

K estimated off Kuwaiti waters were much less than those from the Indian waters. The reason may be attributed to the vide variation in the temperature (16° – 30°C) in a year.

MORTALITY AND STOCK SIZE: Total instantaneous mortality coefficient (Z) was estimated (Jones and van Zalinge 1981) as 5.4 which was taken an approximation (Fig. 4). Z obtained by cohort analysis was 5.2 which was close to the value obtained by Jones and van Zalinge method. M/K ratio of 1.5 and F/Z of 0.8 were used as input for cohort analysis (Table 1). The average F was 4.2 at the length > = 230. Length converted Thompson and Bell analysis indicated MSY of 9 551 tonnes (at F/Z, 0.799) which was close to the present average yield (1984–88). The biomass at MSY was 5 863 tonnes (Table 2).

Karnataka: In Karnataka the study conducted on silver pomfret gave following results.

AGE AND GROWTH: The growth parameters estimated for Karnataka were L_∞ = 360 mm and K = 0.69 (Fig. 5). Lower L_∞ compared to Maharashtra may be attributed to high fishing pressure off Karnataka, as a result of which the species is not allowed to grow.

MORTALITY AND STOCK SIZE: The total instantaneous mortality coefficient (Z) calculated by Jones and van Zalinge method was 5.054 (Fig. 6). Z obtained by cohort analysis at and greater than 200 mm length was 5.122 (Table 3). Length converted Thompson and Bell analysis indicated MSY at 374 tonnes at the relative fishing effort of 0.5 (Table 4) indicating that the stock off Karnataka is heavily fished. It is also evident that the resource off Karnataka is of lesser magnitude (Fig. 1) and it cannot sustain heavy fishing pressure as that of Maharashtra. The species is not in a position to attain L_∞ as compared to that of Maharashtra due to heavy fishing pressure, a case of growth overfishing.

Stock assessment of black pomfret Formio niger

Kerala: The results of stock assessment studies made for Kerala are given below.

LENGTH-WEIGHT RELATIONSHIP: The relationship between total length and weight of *F.niger* was estimated from 212 fish taken from commercial catch. The relationship is as

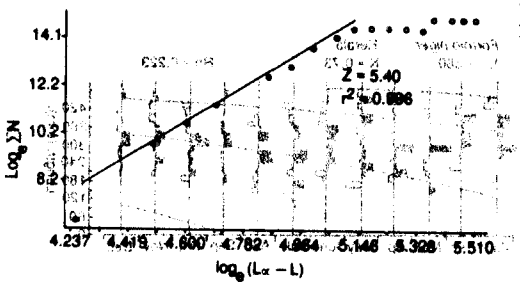


Fig. 4. Estimation of instantaneous mortality coefficient Z of *Pampus argenteus* (Maharashtra) by Jones and van Zalinge method.

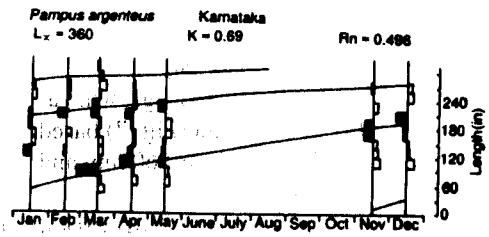


Fig. 5. The growth curve of *Pampus argenteus* identified by ELEFAN (Karnataka).

Table 1. Results of length cohort analysis of *Pampus argenteus* (Maharashtra)

Size group (mm)	C'	N'	F/Z	F	Z	C x W
140-150	29.9	2 638.7	0.01	0.01	1.06	3
150-160	33.5	2 582.4	0.01	0.01	1.06	4.1
160-170	52.7	2 524.2	0.02	0.02	1.07	7.8
170-180	113.4	2 462.1	0.04	0.05	1.1	20
180-190	240.2	2 392.2	0.09	0.1	1.15	50.2
190-200	662.6	2 300.9	0.22	0.29	1.34	162.2
200-210	1 361.7	2 165.5	0.37	0.63	1.68	387.1
210-220	2 460	1 955.7	0.55	1.26	2.31	807.2
220-230	3 613.4	1 646.4	0.68	2.9	3.24	1 359
230-240	4 418.1	1 241.7	0.77	3.56	4.61	1 893.5
240-250	4 252.7	794.9	0.84	5.35	6.4	2 065.6
250-260	1 915.8	460.8	0.8	4.16	5.21	1 049.3
260-270	929.4	291.5	0.75	3.19	4.24	571.4
270-280	703.3	184.7	0.78	3.81	4.86	483.3
280-290	472	102.4	0.81	4.61	5.66	361.1
290-300	250.9	45.8	0.83	5.28	6.33	212.9
300 above	136.7	32.6	0.8	4.2	5.25	128.1
	21 646.3	23 822.5				9 565.8

Mean F(L)>= 230): 4.16; ', In thousand

Table 2. Results of Thompson and Bell analysis of *Pampus argenteus* (Maharashtra)

X	Yield	Mean biomass
0	0	21 729
0.2	7 203	12 319
0.4	8 900	9 057
0.6	9 396	7 470
0.8	9 536	6 547
1	9 553	5 947
1.2	9 526	5 525
1.4	9 481	5 211
1.6	9 432	4 968
1.8	9 382	4 772
2	9 334	4 610

MSY = 9 551, X = 1.0, Biomass MSY = 5 863

follows:

log W = —4.26513 + 2.7921841 log L

ESTIMATION OF GROWTH: The growth parameters estimated for Kerala (Fig. 7) based on the gill net catch were : L_∞ = 560 mm and K = 0.73 (annual).

ESTIMATION OF MORTALITY AND STOCK SIZE: Total instantaneous mortality coeffi-

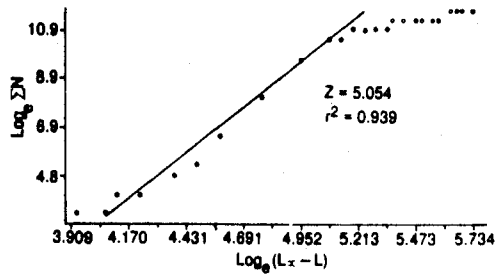


Fig. 6. Estimation of instantaneous mortality coefficient Z of *Pampus argenteus* (Karnataka) by Jones and van Zalinge method.

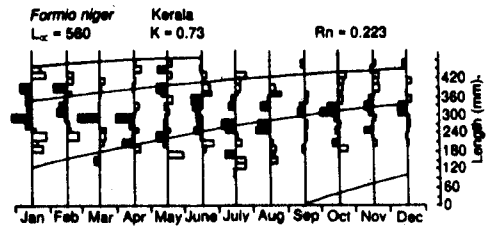


Fig. 7. The growth curve of *Formio niger* identified by ELEFAN (Kerala).

Table 3. Results of length cohort analysis of *Pampus argenteus* (Karnataka)

Size group (mm)	C (×1000)	N (×1000)	F/Z	F	Z	C × W
50-60	0.3	190.5	0	0	1.04	0
60-70	1.6	187.26	0.01	0.01	1.05	0.01
70-80	18.38	183.5	0.08	0.1	1.14	0.26
80-90	46.72	178.54	0.2	0.26	1.3	0.95
90-100	64.78	172.24	0.26	0.38	1.41	1.84
100-110	147.62	163.02	0.46	0.91	1.95	5.65
110-120	109.2	152.28	0.41	0.72	1.76	5.48
120-130	96.74	143.06	0.39	0.68	1.72	6.24
130-140	99.26	133.82	0.42	0.74	1.78	8.06
140-150	56.1	125.74	0.3	0.45	1.49	5.64
150-160	28.66	119.86	0.19	0.23	1.28	3.52
160-170	98	112.28	0.46	0.87	1.91	14.53
170-180	108.98	101.52	0.5	1.07	2.11	19.28
180-190	133.26	89.06	0.59	1.5	2.53	27.85
190-200	100.52	76.64	0.56	1.31	2.35	24.6
200-210	194.24	61	0.75	3.18	4.22	55.24
210-220	177.58	41.32	0.8	4.3	5.33	58.26
220-230	128.62	24.36	0.83	5.28	6.32	48.38
230-240	60.36	13.18	0.81	4.58	5.62	25.87
240-250	31.36	7.26	0.8	4.31	5.36	15.23
250-260	24.02	3.38	0.87	7.1	8.14	13.16
260-270	5.98	1.02	0.83	5.22	6.26	3.67
270 plus	3.22	0.76	0.8	4.16	5.2	2.22
	1735.5	2281.7				345.94

Mean F (L)>= 200): 4.082

cient (Z) calculated by length converted catch curve analysis was 4.2 (Fig. 8) for Kerala with co-relation coefficient of 0.976. Z obtained by cohort analysis was 4.4 with M/K ratio of 1.5 and F/Z of 0.8 (Table 5). The results obtained from Jones' length cohort analysis when used in the length converted Thompson

Table 4. Results of Thompson and Bell analysis of *Pampus argenteus* (Karnataka).

X	Yield	Mean biomass
0	0	983
0.2	323	500
0.4	372	345
0.6	371	272
0.8	359	228
1	345	199
1.2	332	177
1.4	319	160
1.6	307	147
1.8	296	135
2	286	125

MSY = 374 tonnes, X = 0.5, Biomass MSY = 308 tonnes

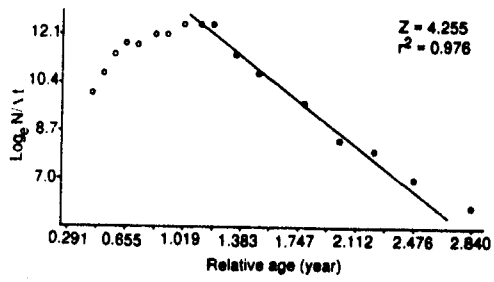


Fig. 8. Estimation of instantaneous mortality coefficient Z of *Formio niger* (Kerala) by Length converted catch curve analysis.

Table 5. Results of length cohort analysis of *Formio niger* (Karnataka)

Size group (mm)	C (×1000)	N (×1000)	F/Z	F	Z	C × W
100-120	0.19	338.04	0	0	1.1	0.01
120-140	0.19	330.48	0	0	1.1	0.01
140-160	20.91	321.96	0.06	0.06	1.16	1.37
160-180	42.92	311.88	0.11	0.14	1.23	3.97
180-200	74.53	299.52	0.19	0.25	1.34	9.39
200-220	128.83	283.68	0.29	0.45	1.55	21.45
220-240	144.07	264.6	0.33	0.54	1.64	30.89
240-260	222.36	240.96	0.46	0.92	2.02	60.14
260-280	239.91	212.28	0.51	1.13	2.23	80.39
280-300	322.59	177.6	0.62	1.82	2.91	131.91
300-320	385.98	134.16	0.72	2.88	3.97	190.07
320-340	344.2	87.96	0.78	3.91	5.01	201.76
340-360	155.59	54	0.72	2.88	3.98	107.46
360-380	90.52	34.92	0.71	2.62	3.72	73.89
380-400	65.95	21.48	0.74	3.07	4.17	61.59
400-420	35.62	10.68	0.73	3.01	4.11	38.24
420-440	10.3	6.84	0.58	1.52	2.61	12.63
440-460	11.13	3.84	0.72	2.86	3.96	15.51
460-480	4.43	1.44	0.72	2.87	3.97	6.97
480 plus	1.78	0.36	0.8	4.38	5.48	3.13
	2 302	3 136.68				1 050.78

Mean F (L)>= 320): 3.306

and Bell analysis, gave an estimated current size of stock and biomass at different level of fishing (Table 6). It is evident that the present (1984–88) yield is about 1 051 tonnes per annum at the exploitation ratio (F/Z) 0.75. The MSY was 1 055 tonnes at relative fishing effort of 0.8 which requires reduction in effort to the extent of 20%.

Table 6. Results of Thompson and Bell analysis of *Formio niger* (Kerala).

X	Yield	Mean biomass
0	0	2 862
0.2	790	1 648
0.4	988	1 162
0.6	1 045	907
0.8	1 055	754
1	1 048	654
1.2	1 034	584
1.4	1 018	532
1.6	1 001	493
1.8	985	462
2	969	436

MSY = 1 055 tonnes, X = 0.8, Biomass MSY = 754 tonnes

Karnataka: From Karnataka stock assessment studies gave following results.

AGE AND GROWTH: The growth parameters estimated for Karnataka based on the length frequency obtained from trawl catches (Fig. 9) were: L_∞ = 550 mm and K = 0.69 (annual).

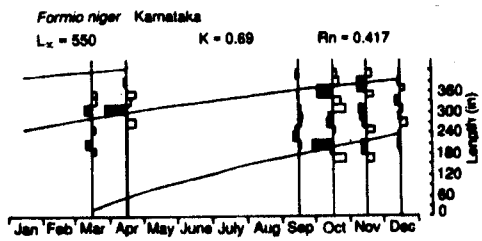


Fig. 9 The growth curve of *Formio niger* identified by ELEFAN (Karnataka).

Table 7. Results of length cohort analysis of *Formio niger* (Karnataka)

Size group (mm)	C (×1000)	N (×1000)	F/Z	F	Z	C × W
70-90	56.76	969.54	0.05	0.06	1.09	0.66
90-110	245.52	939.18	0.2	0.26	1.3	5.25
110-130	630.3	889.68	0.41	0.71	1.74	22.25
130-150	555.72	828.3	0.39	0.67	1.71	30.01
150-170	1 547.7	731.94	0.67	2.11	3.15	121.05
170-190	2 551.56	557.7	0.82	4.68	5.61	276.75
190-210	2 187.24	354.42	0.86	6.17	7.2	317.89
210-230	1 404.48	194.04	0.87	7.24	8.28	266.02
230-250	453.42	106.26	0.8	4.27	5.3	109.36
250-270	305.58	66.66	0.82	4.58	5.61	92.17
270-190	205.26	38.28	0.84	5.33	6.36	76.15
290-310	103.62	20.46	0.83	5.11	6.15	46.7
310-330	46.86	10.56	0.81	4.4	5.44	25.26
330-350	42.24	3.96	0.9	9.4	10.44	26.78
350 plus	7.92	1.98	0.8	4.14	5.18	5.86
	10 344.18	5 712.96				1 422.16

Mean F(L_)>= 170: 5.419

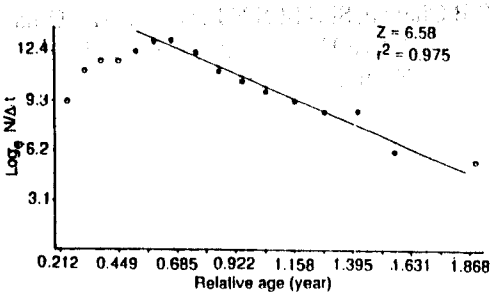


Fig. 10. Estimation of instantaneous mortality coefficient Z of *Formio niger* (Karnataka) by length converted catch curve analysis.

MORTALITY AND STOCK SIZE: Z estimated by length converted catch curve was 6.58 with corelation coefficient of 0.975 (Fig. 10). Z obtained from cohort analysis was 6.45 with identical M/K ratio and F/Z (Table 7). The length converted Thompson and Bell analysis indicated MSY of 1 856 tonnes at the relative fishing effort of 0.412 (Table 8) with biomass MSY 924 tonnes. This indicated that the fishing effort has to be reduced to the extent of 60%.

Table 8. Results of Thompson and Bell analysis of *Formio niger* (Karnataka).

X	Yield	Mean biomass
0	0	5 483
0.2	1 867	1 933
0.4	1 872	1 010
0.6	1 695	655
0.8	1 536	484
1	1 414	389
1.2	1 320	329
1.4	1 246	289
1.6	1 187	260
1.8	1 139	238
2	1 098	221

MSY = 1 856 tonnes, X = 0.412, Biomass MSY = 924 tonnes

DISCUSSION

On an average 10 218 tonnes of *P. argenteus* was landed in Maharashtra mainly by drift net. However, during the five-year period large quantities of it were landed at Bessein (av. 2 522 tonnes) where dol net was suitably modified for catching *P. argenteus*. As the mesh size of dol net is 60–70 mm the

majority of fishes netted were below 100 mm. The peak landings (5 612 tonnes) at Bessein were recorded in 1988 by dol nets. The total landings of *P. argenteus* was highest in Maharashtra during the same period. In 1991 it came down to 565 tonnes which contained very less young ones compared to the earlier year indicating recruitment overfishing. The gill net catches during the observation period consisted of size range of 140 to 345 mm. It is pertinent to mention that the fish grows to 390 mm (furcal length). This shows that there was growth overfishing. Based on the landings of 1984–88, the MSY was estimated at 9 551 tonnes and the present average yield is close to MSY. Large-scale netting of young ones (300–350 mm) was also recorded from Nawabunder - Jaffrabad coast (Gujarat) by Gopalan (1967) and Zafar Khan (1982) in dol nets. Dol net is a gear used for catching mainly Bombay duck and non-penaeid prawns at some centres. Zafar Khan (1989) recorded large number of young ones of *P. argenteus* during February–May and suggested the need to regulate the fishing by closing of operations during this period. In an artisnal fishery like dol, only two types of regulations are possible (i) mesh size regulation and (ii) closing of fishing season. Pomfrets being deep-body fish, mesh regulation will not be effective.

Though the average catch of *P. argenteus* off Karnataka was mere 346 tonnes, the result indicate overfishing to the extent of 50%. *P. argenteus* in Karnataka was caught mainly by trawlers, though, of late, large quantities were landed by purse seiners. The exploratory fishing operations conducted revealed highly potential fishing grounds only off Gujarat (55–90 m depth) and Maharashtra. The meagre resource off Karnataka is already heavily fished and can not sustain high fishing pressure exerted further by the purse seiner. Lower value of L_{-} (360 mm) is an indication of growth overfishing; the majority of the catch was in the size range of 30–270 mm.

Black pomfret forms an important fishery in Maharashtra and Gujarat. It shows an increasing catch trend in Maharashtra. In Karnataka, the present (1984–88) yield is 1 428 tonnes and the MSY is 1 856 tonnes; the effort needs to be reduced by 60%. *F. niger* was landed mainly by trawlers. Of late, purse seiners contributed as much as 900 tonnes of the landings. Probably it is this gear which causes much damage to the resource. In Kerala, the present annual yield of *F. niger* is 1 048 tonnes and MSY is 1 055 tonnes which necessitates the reduction of effort by 20%.

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